ASSESSMENT OF THE HYDRAULIC REGIME OF FISH HABITAT ENHANCEMENT STRUCTURES CASTLE RIVER AT RODEO GROUNDS

by

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1. Project Overview (Objective and Methods)

The hydraulic regime of fish habitat enhancement structures in the Castle River at the Rodeo Grounds south of Cowley were assessed using streamflow measurements collected by student groups from the Environmental Sciences Department of Lethbridge Community College on April 10, 1995. The structures assessed were deflecting groynes and a large v-sill located downstream (Figure 1).

Six groups of students performed the measurements, consisting of distance, depth and velocity measurements at 1.0 m intervals across the channel at selected sections upstream, at and downstream of the structures. The selected sections are indicated on Figure 1. Only the first three groynes could be measured, since the depths became too deep to wade beyond groyne #3. The depths and velocities were obtained with Price 622AA current meters suspended from top-setting wading rods, and calibrated at the National Hydraulics Laboratory in Burlington, ON. The field method employed was the standard mid-section method used by the Water Survey of Canada, with velocities obtained at 0.6D from the water surface for depths $\leq$ 0.7 m, and at 0.2D and 0.8D for depths greater than 0.7m. In addition, the distances between sections were chained and the relative water surface elevation at the right bank determined with an automatic level. Flow computations were completed according to the mid-section method, and checked with spreadsheet computations by the author.

From these data, computer-generated two- and three-dimensional plots of isovelocity lines were constructed using an inverse-distance interpolation method. Cross-sectional profiles of depth and velocity and longitudinal profiles of the water surface at the right bank were plotted. The cross-sectional profiles are plotted at the same scale for a given type of structure to facilitate overlay comparison on a light table.

2. Results

2.1 Control Check of Discharge Measurements

Table 1 lists the total discharge measured at each section, followed by a summary of descriptive statistics. The average discharge is 6 m^3/s. Figure 2 shows the values plotted as an I Chart with upper and lower control limits computed by MINITAB statistical software. The flow measurements are within the control limits and do not display any of the out-of-control characteristics identified in standard process control methods; however, the last six measurements taken above and below the V-sill vary substantially more than the first six taken at and between the groynes. This is attributable to greater variability of channel characteristics among the last six measurements, ranging from shallow riffle to laminar sections to the drop over the sill to deep pools below the sill. Variance in flows likely resulted from the use of six different field crews to obtain measurements. Calibration variance among the six current meters used is considered minor.

100-03985/

Figure 1: Orthophoto of Castle River at Rodeo Grounds Showing Location of Measurement Sections

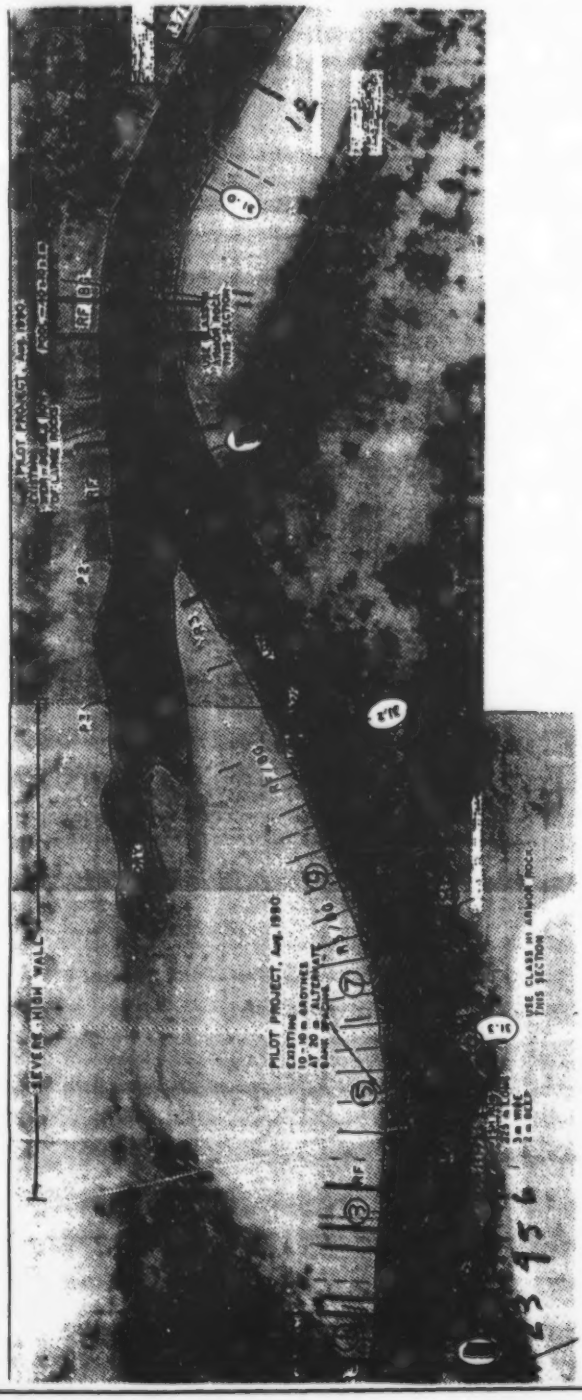


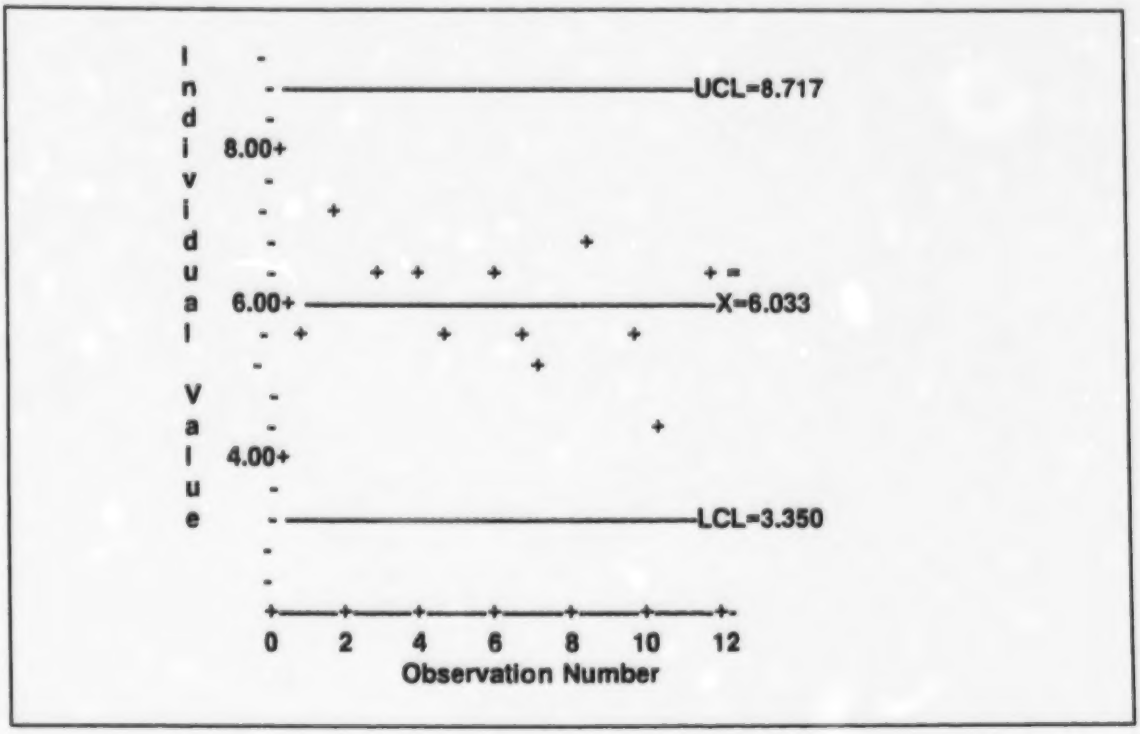
Table 1: Summary of Total Discharge at Measured Sections

STATION	Discharge (m^3/s)
Above Groyne 1	5.8
At Groyne 1	7.1
Above Groyne 2	6.3
At Groyne 2	6.3
Above Groyne 3	5.8
At Groyne 3	6.6
Riffle U/S of V-Sill	5.6
Laminar section U/S of V-Sill	5.2
V-Sill Approach	7.0
Pool Edge	5.7
Laminar section D/S of pool	4.5
Riffle D/S of pool	6.5

N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN
12	6.033	6.050	6.080	0.751	0.217

MIN	MAX	Q1	Q3
4.500	7.100	5.625	6.575

Figure 2: I Chart for Discharge (m^3/s)



2.2 Two- and Three-Dimensional Isovelocity Plots

Figures 3 to 6 show the two- and three-dimensional isovelocity plots for the groynes and V-sill respectively, plotted at 0.1 m/s increments. The structure locations and channel boundaries are overlain onto the isovelocity lines (isovels). Due to the methodology employed by the interpolation routine of the software used, isovels are extrapolated beyond channel boundaries at the V-sill, but can be ignored.

Figure 3 indicates that, for the average discharge rate of 6 m^3/s, the groynes accelerate the average velocity in the centre of the channel to between 1.1 and 1.3 m/s, and that the velocity in the pool behind the groyne is 0.1 m/s or less. Hydrometric notes (Appendix I) indicate that point velocities at 0.6D were as high as 1.6 m/s and possibly as high as 1.8 m/s, although that is an estimated value since the crew could not maintain their footing at that point. Studies by the U.S. Geological Survey in mountain rivers have indicated that surface velocities measured by a Price AA meter are approximately 1.5 times greater than mean velocities (Jarratt, 1990). Consequently, surface velocities at the groynes are estimated to range from 0.15 m/s or less in the pools behind the groynes and 1.7 to 2 m/s in the channel centre.

Figure 3: Two-dimensional Isovelocity Plot of Groynes

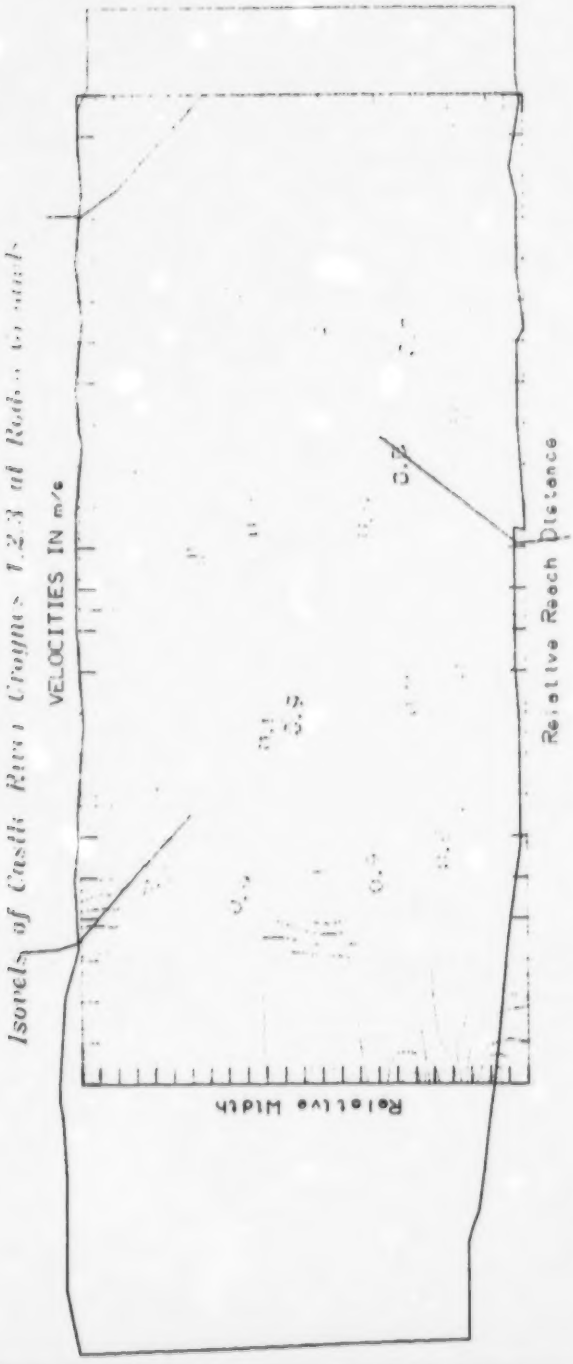


Figure 4: Three-dimensional Isovelocity Plot of Groynes

Figure 5 indicates that the flow in the centre of the channel accelerated from an average velocity of 0.7 m/s to 1.1 m/s at the V-sill notch. The flow velocity through the pool section was approximately 0.3 m/s, accelerating to 0.5 m/s at both the laminar and riffle sections below the pool. Velocities reduced to 0.1 m/s along the right bank (inside bend of the channel) and ranged from 0.3 to 0.6 m/s along the left bank (outside bend of the channel). Using the U.S.G.S. factor of 1.5, the surface velocities are estimated to be 1.1 m/s in the centre of the channel approaching the V-sill, 1.7 m/s at the sill notch, 0.5 m/s through the pool, and 0.8 m/s in the centre of the channel downstream of the pool. The surface velocities are estimated at 0.2 m/s along the inside bend, and ranging from 0.5 to 0.9 m/s along the outside bend.

2.3 Cross-sectional Depth and Velocity Profiles

Figures 7 to 18 show cross-sectional profiles of channel depth and corresponding average velocity (in the vertical) at the measurement points for the groynes and V-sill sections respectively. The overall mean depth and mean velocity for the section are also indicated. A common scale was used for the sections related to a given structure to facilitate overlay comparison visually on a light table of the changes to the width and depth geometry.

Figures 7 to 12 demonstrate the constriction of flow width and cross-sectional area resulting from the groynes with a consequent increase in the overall mean velocity. Generally point velocities increased with increasing depth except for localized influences of large cobbles and boulders causing flow deceleration at discreet points.

Figures 13, 14 and 17 characteristically show deflection of flow to the outside of the bend, while the weir and pool sections (Figures 15 and 16) are generally symmetrical both in the distribution of depth and velocity. Section 18 also indicates a slight deflection of depth and velocity distribution toward the left bank, but is tending toward symmetry as the reach straightens.

2.4 Longitudinal Water Surface Profiles

Figures 19 and 20 are longitudinal profiles of the water surface, average depth and velocity head for both the groyne and V-sill reaches measured. The lines connecting points are dashed to indicate their approximate nature and that they are extrapolations between points. Since the pool immediately below the V-sill was too deep to wade, it's profile is not accurately represented on the longitudinal profile, as indicated.

3. Reference

Jarrett, R.D. 1990. Hydrologic and Hydraulic Research in Mountain Rivers. Water Resources Bulletin 26(3):pp.419-429.

Figure 5: Two-dimensional Isovelocity Plot of V-Sill

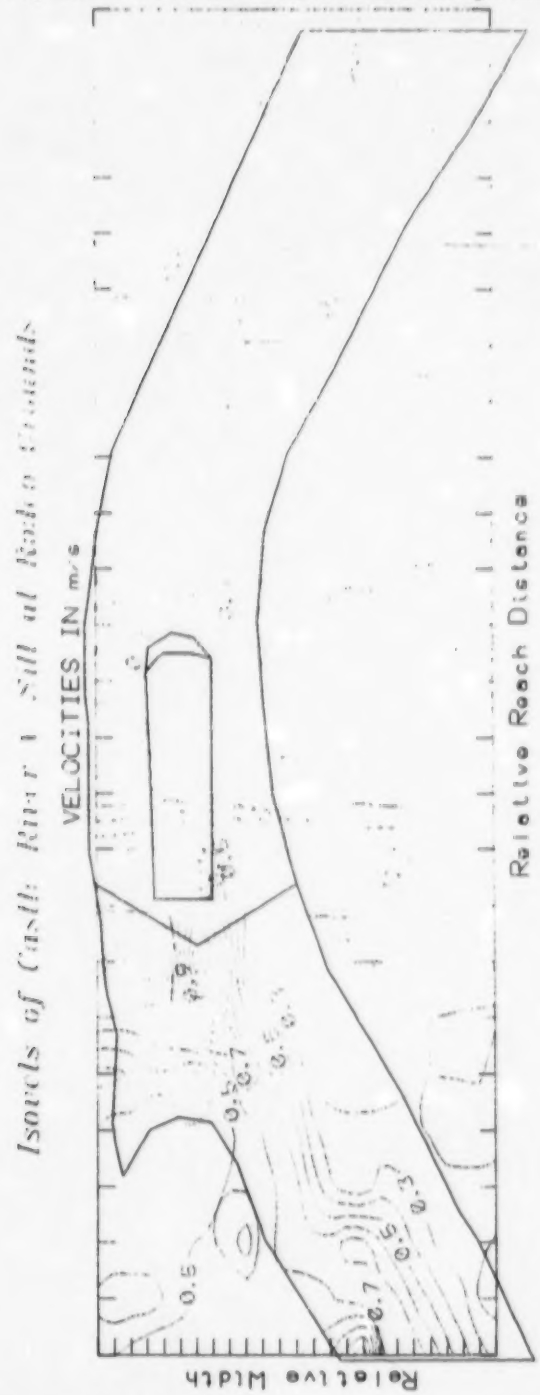


Figure 6: Three-dimensional Isovelocity Plot of V-Sill

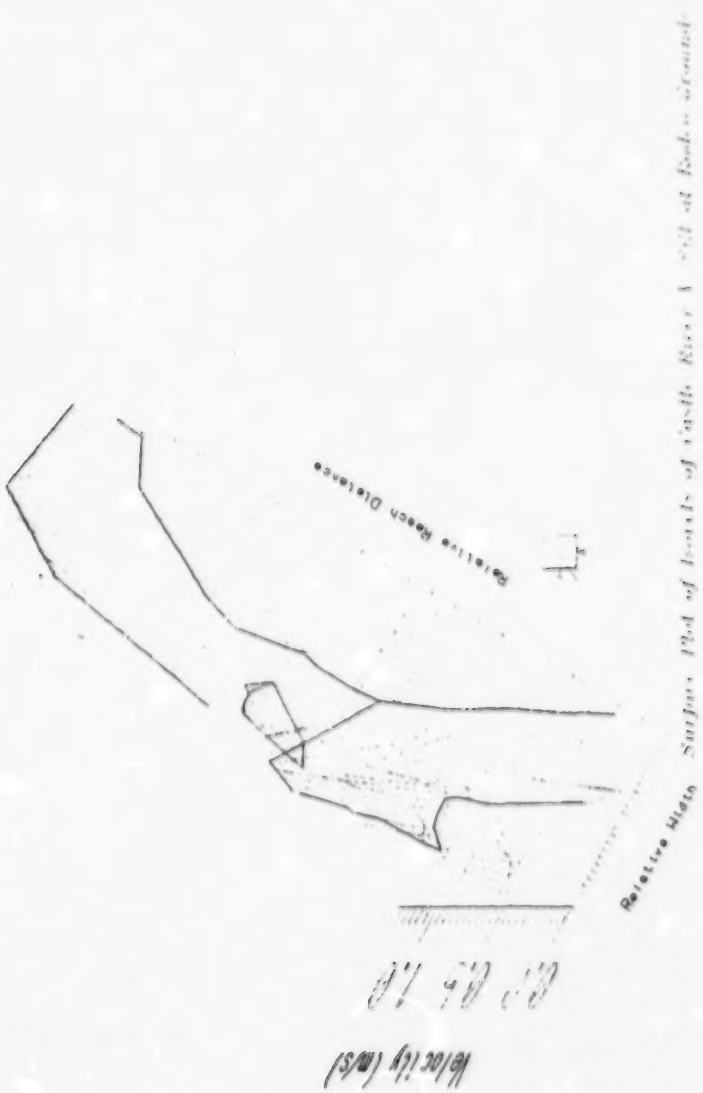


Figure 7: Cross-sectional Profile of Depth and Velocity above Groyne #1

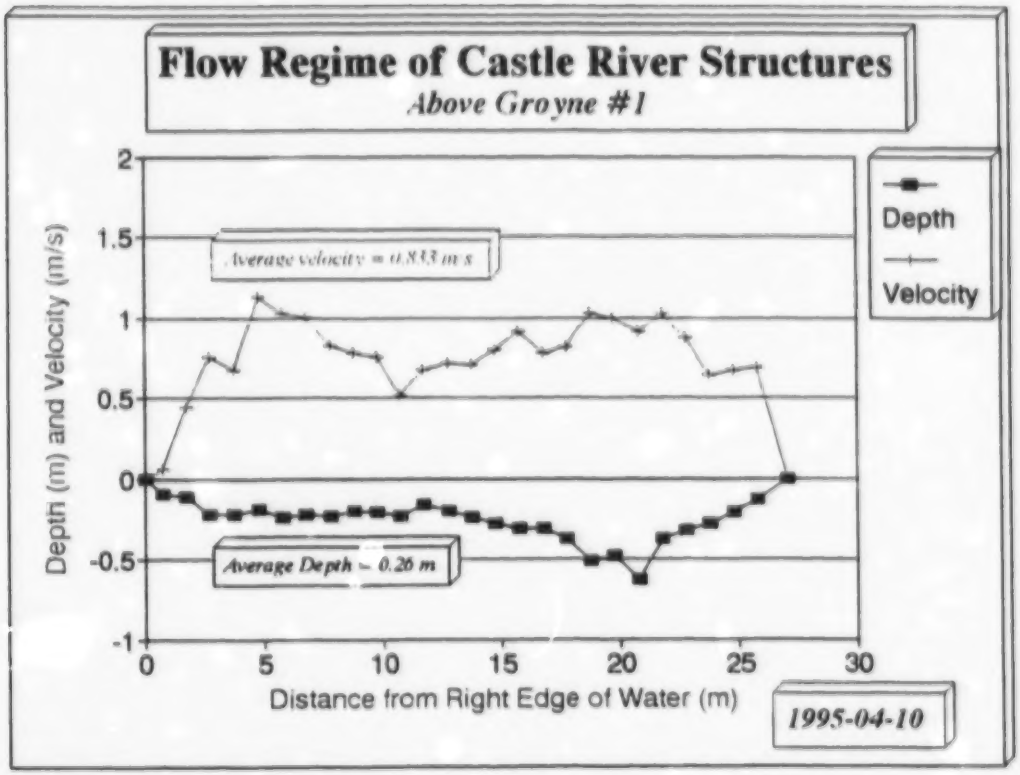


Figure 8: Cross-sectional Profile of Depth and Velocity at Groyne #1

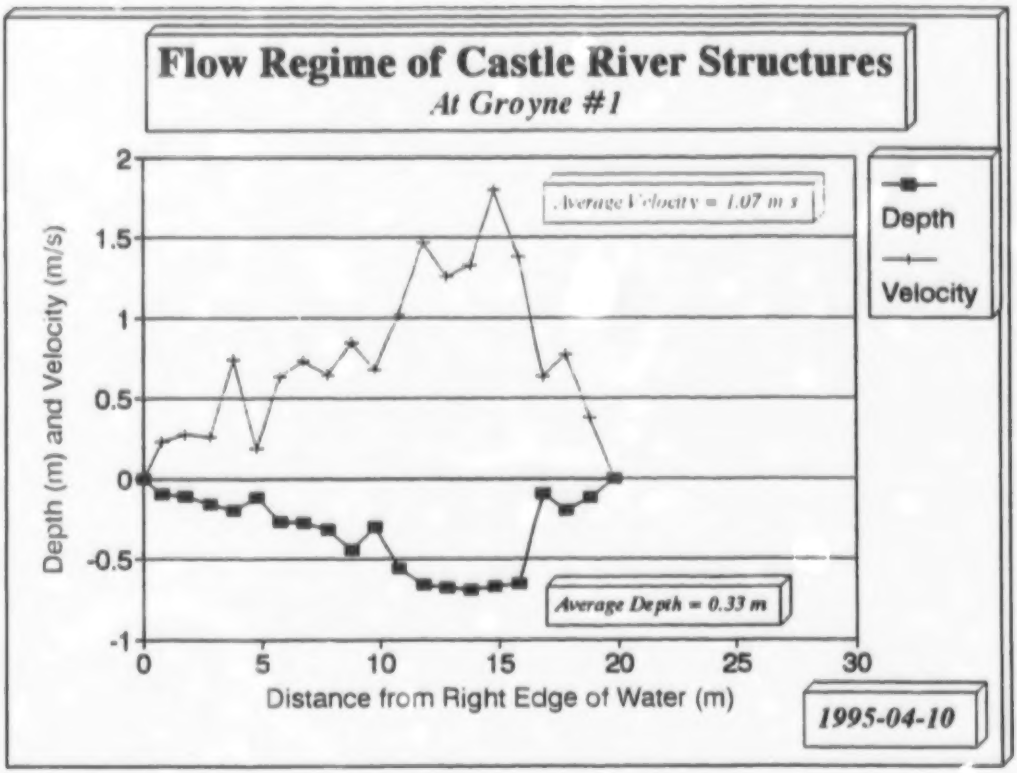


Figure 9: Cross-sectional Profile of Depth and Velocity above Groyne #2

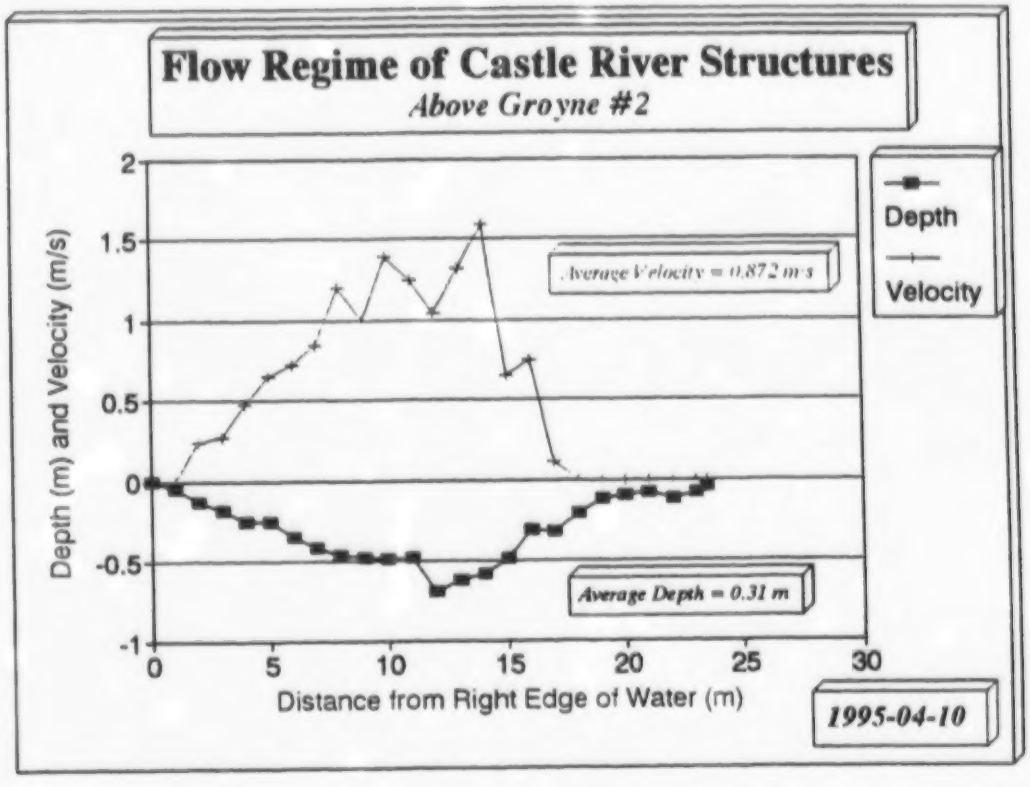


Figure 10: Cross-sectional Profile of Depth and Velocity at Groyne #2

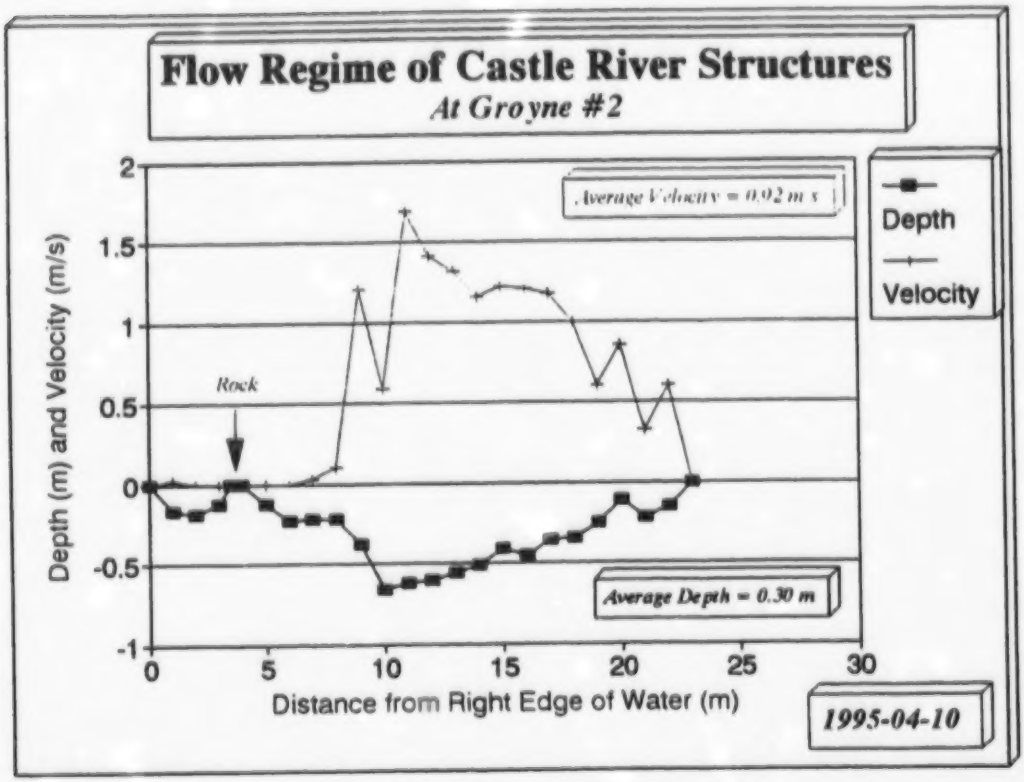


Figure 11: Cross-sectional Profile of Depth and Velocity above Groyne #3

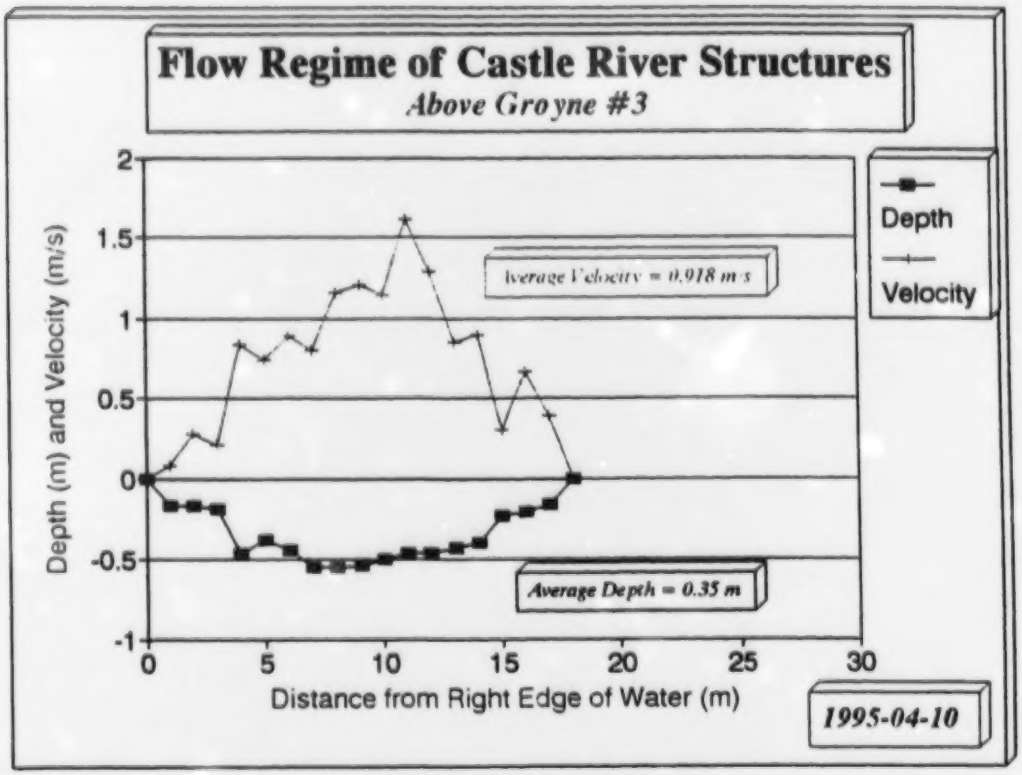


Figure 12: Cross-sectional Profile of Depth and Velocity at Groyne #3

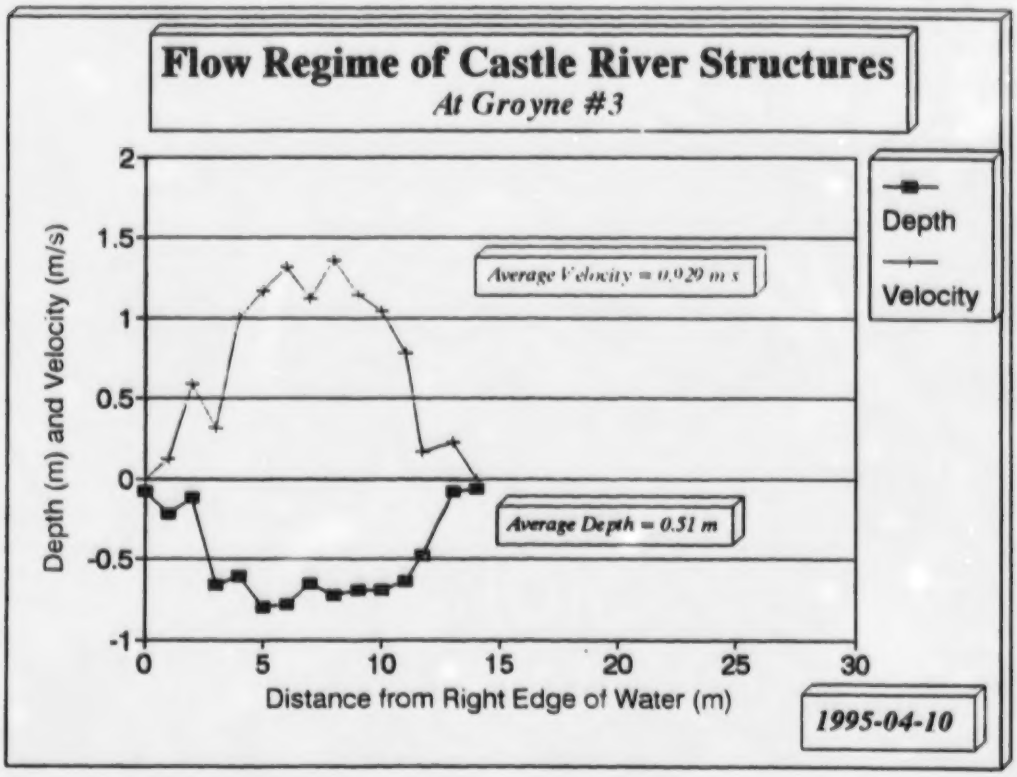


Figure 13: Cross-sectional Profile of Depth and Velocity above V-Sill at Riffles

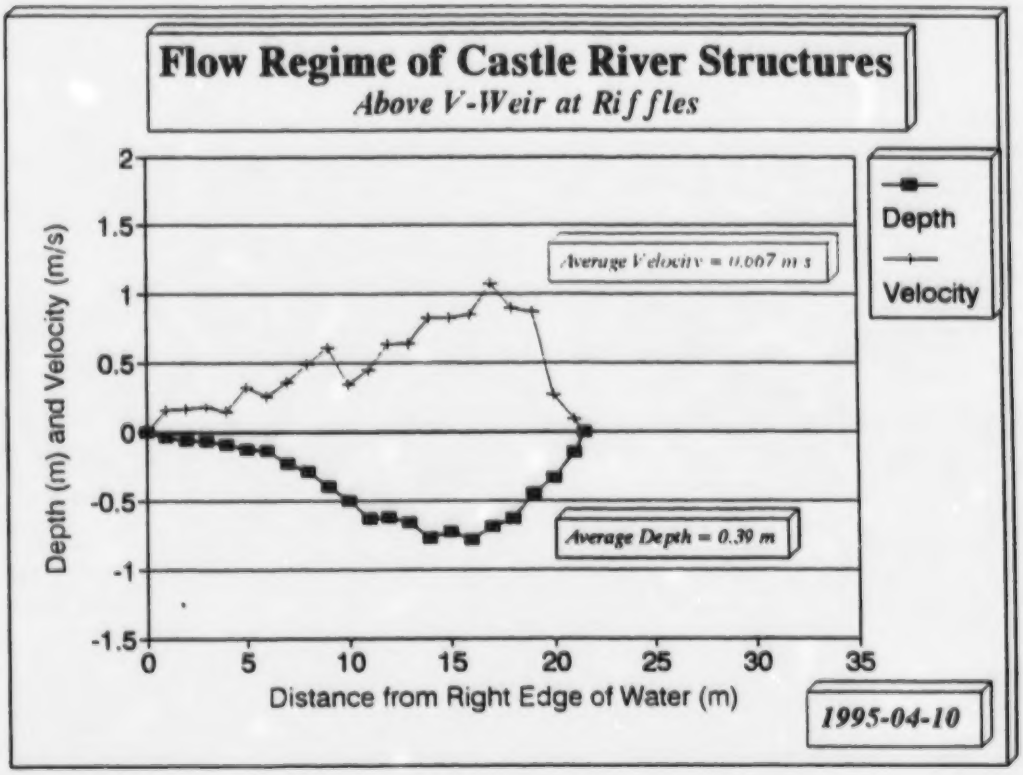


Figure 14: Cross-sectional Profile of Depth and Velocity above V-Sill at Laminar Section

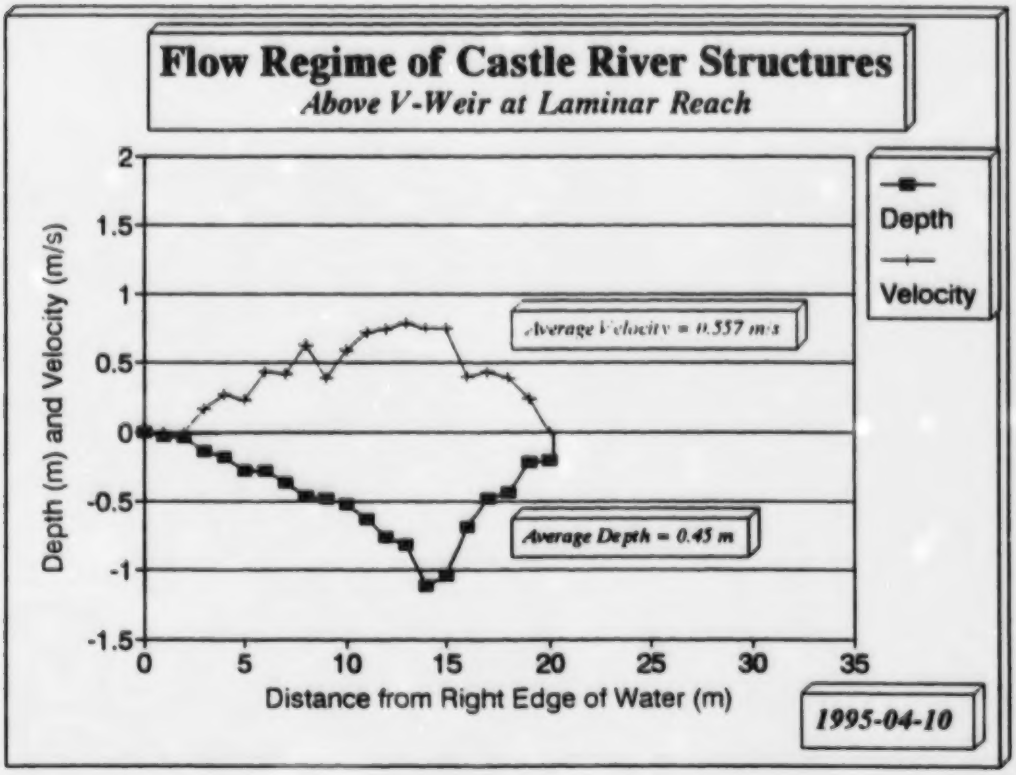


Figure 15: Cross-sectional Profile of Depth and Velocity at V-SIII

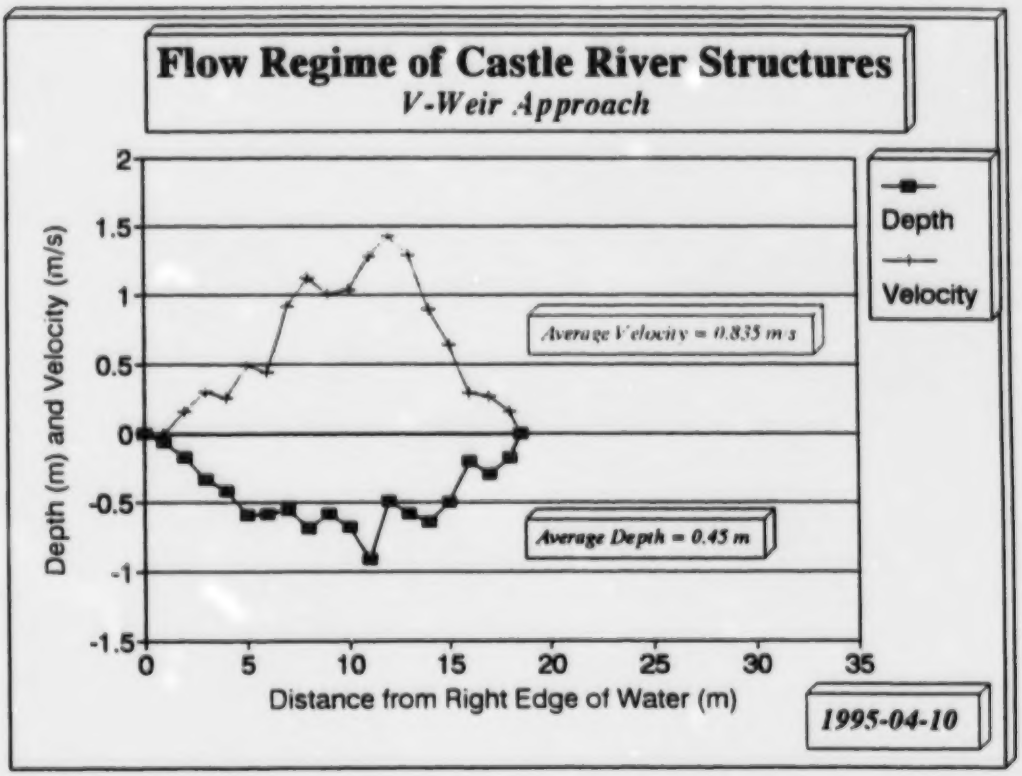


Figure 16: Cross-sectional Profile of Depth and Velocity at Edge of Pool

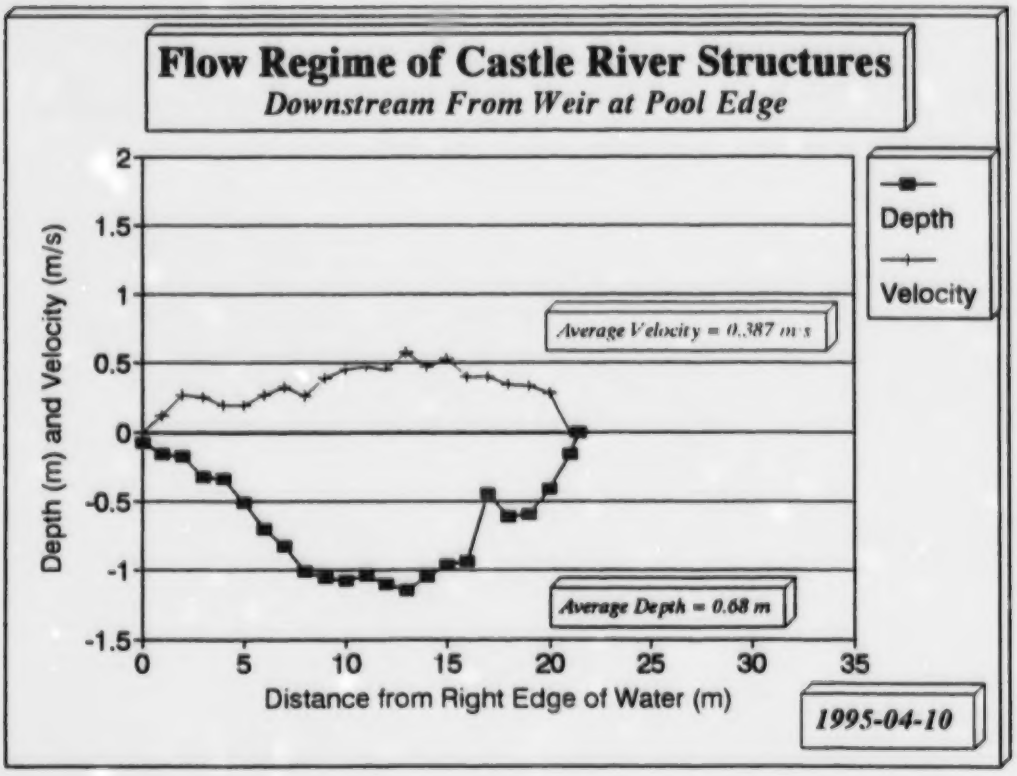


Figure 17: Cross-sectional Profile of Depth and Velocity below V-Sill at Laminar Section

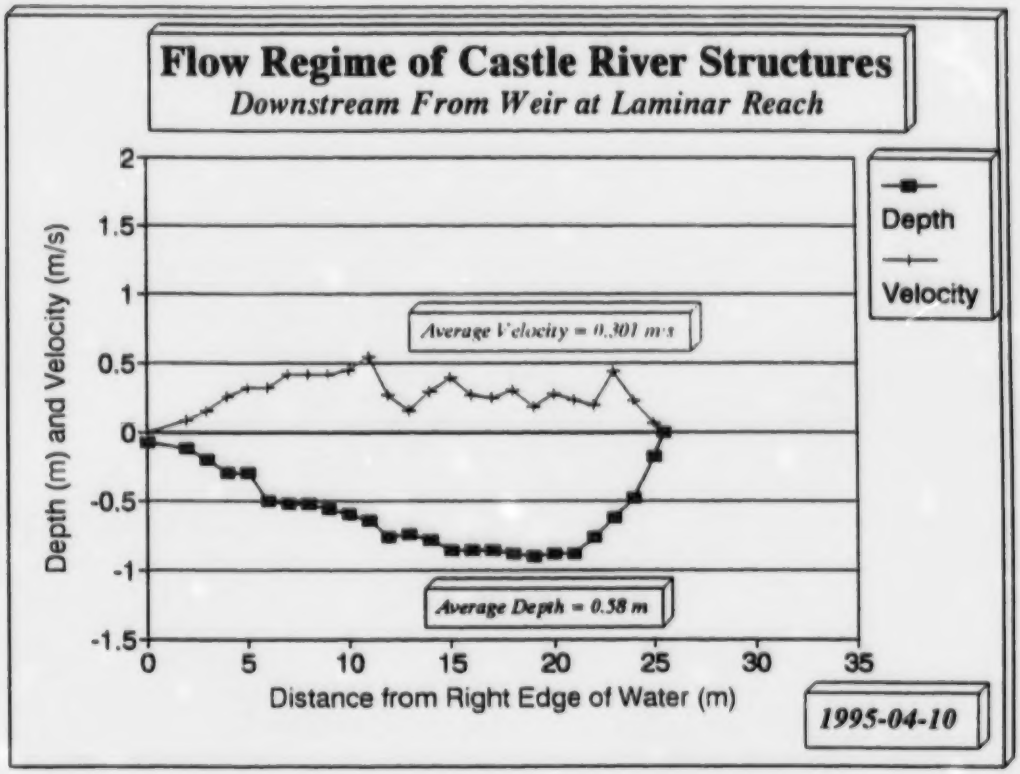


Figure 18: Cross-sectional Profile of Depth and Velocity below V-Sill at Riffles

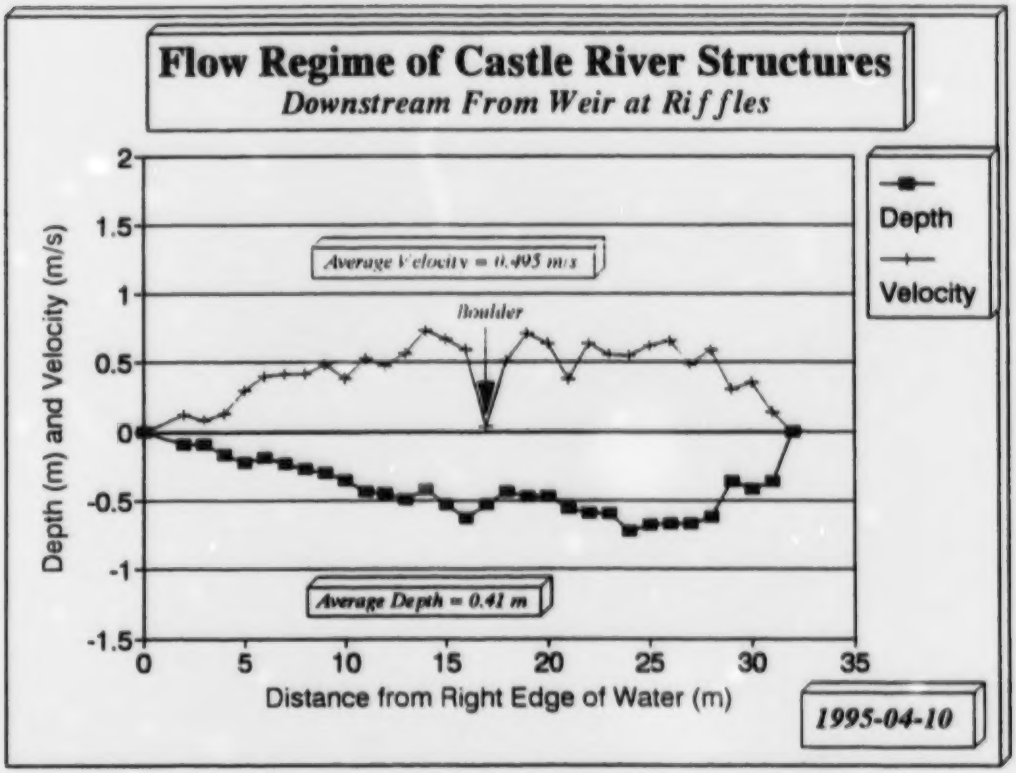


Figure 19: Longitudinal Profile of Water Surface at Groynes

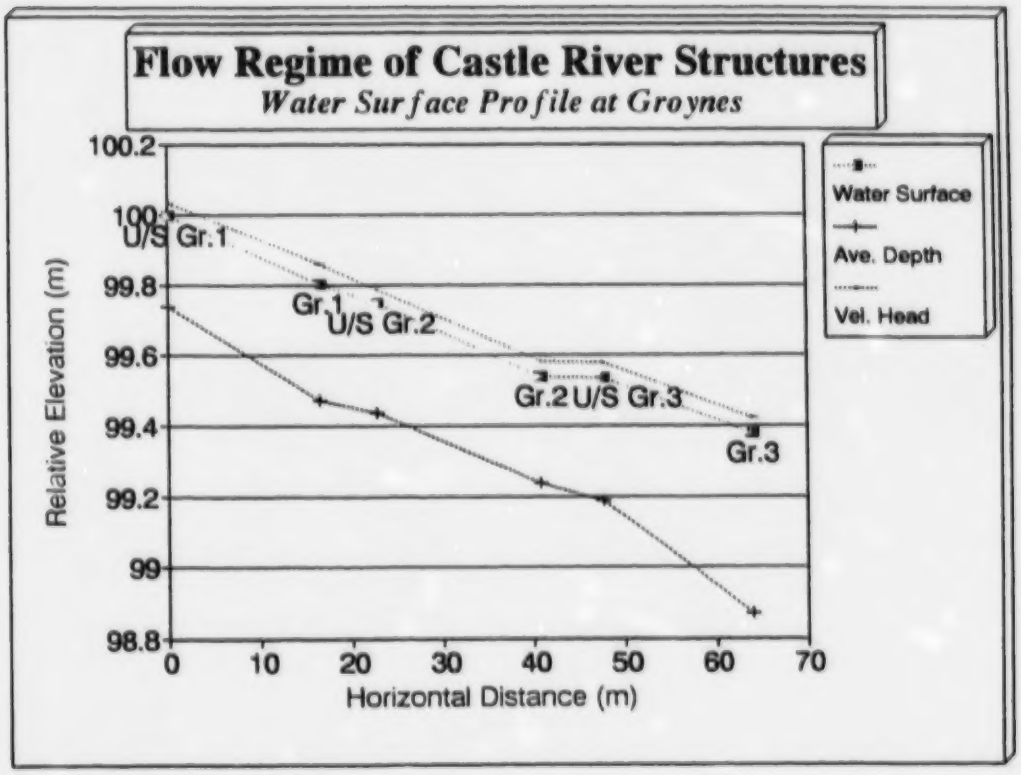
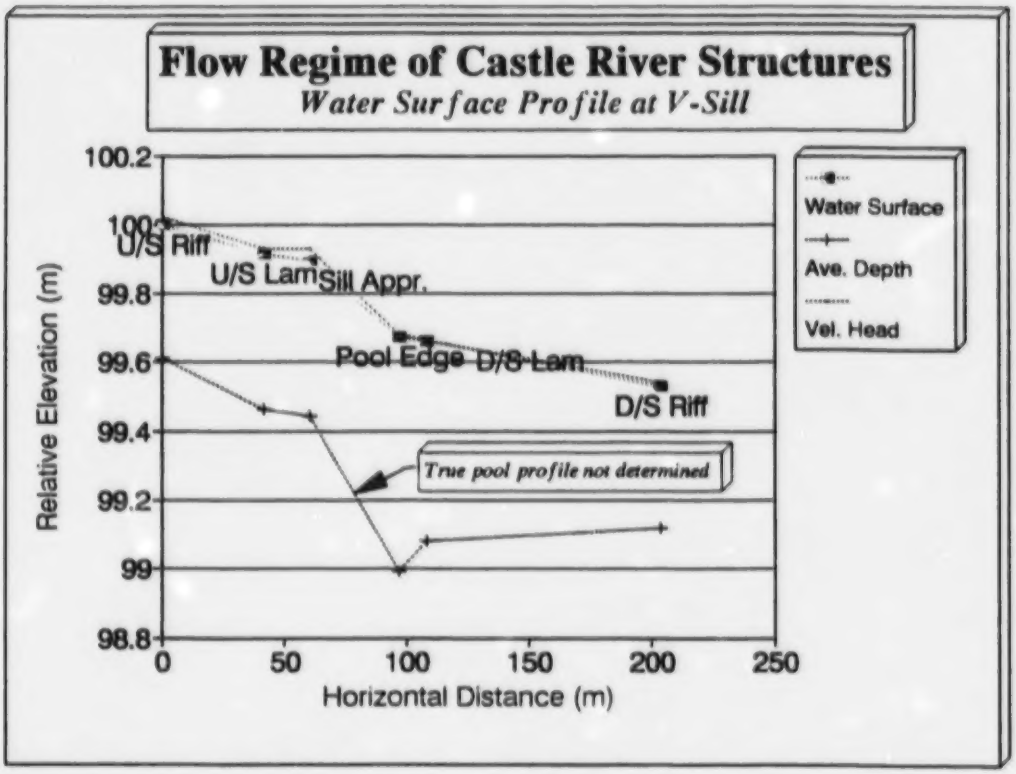


Figure 20: Longitudinal Profile of Water Surface at V-Sill



APPENDIX
HYDROMETRIC SURVEY NOTES

HYDROMETRIC SURVEY NOTES

Station Castle River at Rocky Camp #1 Sta. No. Above Gravels #1

Date April 10 1995 Party Nick Lutz, Bernie Kleinrock, Charlie Vanderhagen

Temp. A 5 °C W .....°C Width 27.05 m Area 6.968 m²

Mean vel. .8338 Corr. M.G.H. ..... Discharge 5.81 m³/s

Measurement began at 1130 ended at 12:15

Levels obtained .....

Gauge Readings				
Time	Vertical	Pen	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number NA 7112

Date calibrated March 19-90

Current meter Price 622 AA .....m

above ..... weight.

Method ..... Coeff. —

No. of vert. sect. .....

Angle of flow .....

Observer visited .....

Book inspected .....

Recorder: Chart removed ..... Supply roll ..... days remaining

Weather conditions Dull, cool Wind NW at 10 Km

Measurement: Wading, cableway, boat, ice cover. Upstream, downstream side of bridge

..... m, km above, below gauge .....

Remarks: Include condition of station equipment .....

readings taken above 1st gravnes (3m)

1st cross-section done

.....

.....

.....

.....

.....

Computed by Bernie Kleinrock Checked by .....

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES maps included.

Wind - [illegible]

.6807 x m/sec + 0.0081

Station [illegible] wxd axd

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time	Velocity At point	Velocity Mean	Area	Discharge
REW										
.25m	.375		0						-	-
1.0m	.875		.09		10	131		.060	.0788	.004728
2	1.0		.11		40	63		.440	.110	.048H
3 m	1.0		22		50	455		.756	.220	.16632
4	1.0		.22		40	40		.669	.22	.14718
5m	1.0		.19		70	405		1.13	.19	.2147
6m	1.0		.24		70	465		1.03	.24	.02472
7m	1.0		.22		60	41		1.004	.22	.22088
8.m	1.0		.23		48	40		0.824	.23	.18952
9.m	1.0		.20		50	44		.782	.20	.1564
10m	1.0		.21		44	40		0.757	.21	.15897
.11m	1.0		.23		30	40		.519	.23	.11937
.12m	1.0		.16		50	51		.675	.16	.108
.13 m	1.0		.20		50	48		.717	.20	.1434
14.m	1.0		.24		50	49		.703	.24	.16872
.15m	1.0		.28		50	43		.800	.28	.224
.16.m	1.0		.31		60	45		.916	.31	.28396
17.m	1.0		.31		50	44		.767	.31	.24242
.18.m	1.0		.37		50	42		.818	.37	.30266
19 m	1.0		.51		60	40		1.029	.51	.52479
20m	1.0		.48		70	46		1.00	.48	.48
21 m	1.0		.63		60	45		.916	.63	.59708
22m	1.0		.37		70	47		1.02	.37	.377H
23m	1.0		.32		60	47		.877	.32	.28064
24m	1.0		.28		40	43		.641	.26	.17948
25	1.0		.21		40	41		.672	.21	.14112

Station 26.9

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time	Velocity At point	Velocity Mean	Area	Discharge
26m	1.15		.13		40	40		.689	.1495	.1030055
	CEW									
27.3	.65									
(27.3 .25)										
27.05	≈27.05								≈6.9683	≈5.81034435
									6.97	m^2
										5.81 m^3/s

[redacted] April 10, 1 [redacted] Instrument [redacted] NA 7101 [redacted] Start [redacted] 1:30 PM [redacted] Party: Kevin B, Kevin G, Briam M, Larry P.

Calibrated: March 19, 1990 Finish 12:35 pm

Station 1. Lumbreck Cowley Rodeo grounds groupe #1

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
0.2 REV	0.4	0								
1.0	0.9	0.10			20	59.5		0.232	0.09	0.0209
2.0	1.0	0.11			20	49.5		0.278	0.11	0.031
3.0	1.0	0.16			20	53.5		0.257	0.16	0.041
4.0	1.0	0.20			50	46		0.737	0.20	0.147
5.0	1.0	0.12			15	55.5		0.188	0.12	0.023
6.0	1.0	0.27			40	43		0.632	0.27	0.171
7.0	1.0	0.28			50	46.5		0.729	0.28	0.204
8.0	1.0	0.32			40	42.5		0.639	0.32	0.204
9.0	1.0	0.44			50	40		0.847	0.44	0.373
10.0	1.0	0.3			40	40		0.679	0.30	0.204
11.0	1.0	0.56			60	40		1.015	0.56	0.568
12.0	1.0	0.66			90	41.5		1.465	0.66	0.967
13.0	1.0	0.68			100	57.5		1.257	0.68	0.855
14.0	1.0	0.69			100	51.5		1.325	0.69	0.914
15.0	1.0	0.67			(2)			1.800	0.67	1.206
16.0	1.0	0.65			100	49		1.379	0.65	0.896
17.0	1.0	0.10			40	43		0.632	0.10	0.063
18.0	1.0	0.20			50	44		0.770	0.20	0.154
19.0	1.0	0.12			15	42		0.377	0.12	0.045
20.0 LEW	0.5	0							0	0
19.8	19.8								6.62	7.73

mean velocity = 1.17 m/s

Station

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge

HYDROMETRIC SURVEY NOTES

Station Castle River at Habitat Enhancement site Above Pond 2 Sta. No.

Date Apr. 10 19 95 Party Emo Stuart Greg Grover Castle Hawk, Brent Satre

Temp. A 10 °C W 4 °C Width 23.5m Area 7.30 m²

Mean vel. 0.866 m/s Corr. M.G.H. Discharge 6.32 m³/s

Measurement began at ended at

Levels obtained

Gauge Readings				
Time	Vertical	Pan	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number TV 3738

Date calibrated

Current meter m

above weight.

Method 0.2:0.4/0.6 Coeff.

No. of vert. sect. 24

Angle of flow 1

Observer visited

Book inspected

Recorder: Chart removed Supply roll days remaining

Weather conditions Wind

Measurement: (Wading) cableway, boat, ice cover. Upstream, downstream side of bridge

m, km above, below gauge

Remarks: Include condition of station equipment

Computed by Brent Satre Checked by

(W-2078-A (1/77) R31-A(M)

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES Castle River above Weir & below riffle

Apr. 10/95

Temp A 12°C W 4°C Width 20.0m Area 9.10 m²

mean vel 0.573 m/s discharge 5.214 m³/s

Station: Castle River at Habitat Enhancement site

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
0	0.5	(1)	—		—	—				—
0	1.0		0.05		0	0		0	0.05	0
0	1.0		0.13		15	44.0		0.238	0.13	0.031
0	1.0		0.18		20	51.5		0.272	0.18	0.049
0	1.0		0.25		30	43.5		0.474	0.25	0.119
0	1.0		0.25		50	52		0.656	0.25	0.164
0	1.0		0.35		50	47		0.725	0.35	0.254
0	1.0		0.42		60	48.5		0.841	0.42	0.353
0	1.0		0.46		80	45		1.203	0.46	0.553
0	1.0		0.49		80	54.5		0.995	0.49	0.479
0	1.0		0.49		100	48.5		1.393	0.49	0.683
0	1.0		0.48		80	43.5		1.244	0.43	0.597
0	1.0		0.69		80	52		1.043	0.69	0.720
0	1.0		0.62		100	51.5		1.313	0.62	0.814
0	1.0		0.58		100	47.5		1.598	0.58	0.927
0	1.0		0.49		40	47		0.650	0.49	0.319
0	1.0		0.31		50	45.5		0.748	0.31	0.232
0	1.0		0.32		15	100.5		0.112	0.32	0.036
0	1.0		0.21		0	0		0	0.21	0
0	1.0		0.12		0	0		0	0.12	0
0	1.0		0.10		0	0		0	0.10	0
0	1.0		0.08		0	0		0	0.08	0
0	1.0		0.12		0	0		0	0.12	0
0	[illegible]		0.09		0	0		0	0.09	0
0.5	0.25	(-1)	0.04		0	0		0	0.04	0
									7.31	6.323

Station: Castle River above Weir site & below Weir

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
0	0.5				0	0		0		
1.0	1.0		0.37							
2.0	1.0		0.60							
3.0	1.0		0.77			47			0.77	0.24
4.0	1.0		0.78		20	51.5		0.272	0.78	0.212
5.0	1.0		0.82		14	47		0.226	0.82	0.185
6.0	1.0		0.81			43.5		0.435	0.81	0.352
7.0	1.0		0.77		30	49.5		0.418	0.77	0.322
8.0	1.0		0.73		20	43.5		0.623	0.46	0.287
9.0	1.0		0.64		10	43.5		0.358	0.75	0.150
10.0	1.0		0.8		40	46		0.704	0.52	0.366
11.0	1.0		0.82			47		0.772	0.82	0.645
12.0	1.0		0.76	2/10	40	46.5	0.765		0.76	0.569
				6/10	50	46.5	0.732	0.740		
13.0	1.0		0.60	2/10	40	46	0.509		0.62	0.384
				8/10	60	46	0.701			
14.0	1.0		0.72	2/10	70	47.5	0.883		1.12	0.847
				7/10	50	43.5	0.513	0.746		
15.0	1.0		1.08	2/10	60	47	0.960		1.04	0.787
				8/10	60	50	0.[illegible]	0.749		
16.0	1.0		0.[illegible]			47		0.[illegible]	0.69	0.[illegible]
17.0	1.0		0.49		30	47		0.439	0.49	0.21[illegible]
18.0	1.0		0.45		30	43.5		0.388	0.43	0.[illegible]
19.0	1.0		[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	0.[illegible]
20.0	0.5	(-2)	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
									9.10	5.[illegible]

HYDROMETRIC SURVEY NOTES

Station #2 @ Groyne - Castle River Sta. No. #2

Date April 10 19 95 Party David Scott, Darryll McLean, Lee Osborn, Val Merrick

Temp. A 6 °C W °C Width 22m Area 6.884 m²

Mean vel. 0.920 m/s Corr. M.G.H. +4 Discharge 6,330 m³/s

Measurement began at 11:30 am ended at 1230 pm

Levels obtained

Gauge Readings				
Time	Vertical	Pen	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number NA 7104

Date calibrated March 19, 1990

Current meter – m

above – weight.

Method 2.8.6 Coeff. –

No. of vert. sect. 25

Angle of flow ⊥

Observer visited

Book inspected

Recorder: Chart removed Supply roll days remaining

Weather conditions Partly Cloudy Wind W @ 5-10 km

Measurement: (Wading) cableway, boat, ice cover. Upstream, downstream side of bridge

m, km above, below gauge

Remarks: Include condition of station equipment

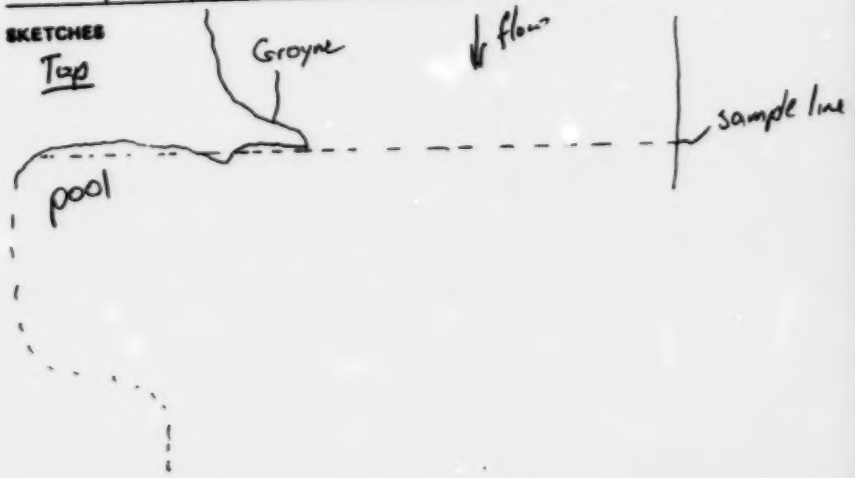
REW is a small backwater pool to 5m - see sketch

Computed by D Scott Checked by

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES



.0 .10 .20 .30 .40 .50 .60 .70 .75 .80

Station

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time	Velocity At point	Velocity Mean	Area	Discharge
REW 0	0.50		0						0	
1	1.00		0.17		2	70		0.024	0.170	0.004
2	1.00		0.19		0				0.190	
3	0.75		0.125						0.094	
LEW 3.5	0.25		0						0	
4 REW	0.50		0						0	
5	1.00		0.25		0				0.125	
6	1.00		0.23		0				0.230	
7	1.00		0.22		2	50.5		0.031	0.220	0.007
8	1.00		0.22		10	65		0.108	0.220	0.024
9	1.00		0.38		80	45		1.204	0.380	0.458
10	1.00		0.66		40	46		0.591	0.660	0.390
11	1.00		0.62		100	40		1.691	0.620	1.048
12	1.00		0.60		100	48		1.410	0.600	0.846
13	1.00		0.56		100	51.5		1.314	0.560	0.736
14	1.00		0.51		80	47		1.153	0.510	0.588
15	1.00		0.41		100	55.5		1.220	0.410	0.500
16	1.00		0.455		100	54		1.209	0.455	0.550
17	1.00		0.36		100	57.5		1.178	0.360	0.424
18	1.00		0.35		80	54.5		0.975	0.350	0.348
19	1.00		0.25		40	45		0.604	0.250	0.151
20	1.00		0.11		60	48		0.848	0.110	0.093
21	1.00		0.27		30	62.5		0.328	0.270	0.072
22	1.00		0.15		40	45		0.604	0.150	0.091
LEW 23	0.50								A: 6.884	6.33
23 m	22.5 ft (bank)									

.85 .90 .92 .94 .96 .97 .98 .99 1.00 .99 .98 .97 .96 .94 .92 .90 .85 .80

.0 .10 .20 .30 .40 .50 .60 .70 .75 .80

Station

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time	Velocity At point	Velocity Mean	Area	Discharge

.85 .90 .92 .94 .96 .97 .98 .99 1.00 .99 .98 .97 .96 .94 .92 .90 .85 .80

HYDROMETRIC SURVEY NOTES

Groynes

Station Castle River Sta. No. 2 1/2

Date April 10 19 95 Party Kendall, Mike, Brent, Dean

Temp. A 14 °C W ? °C Width 19 m Area 6.30 m^2

Mean vel. 9.18 m^3/s Corr. M.G.H. Discharge 5.786 m^3/s

Measurement began at 11:00 ended at 13:00

Levels obtained

Gauge Readings				
Time	Vertical	Pen	Inside	Outside
Weighted M.G.R.		—		
Correction		—		
Correct M.G.H.		—		

Meter number NA 5137

Date calibrated Jan 1990

Current meter — m

above — weight.

Method 0.6 Coeff. —

No. of vert. sect. 17

Angle of flow —

Observer visited —

Book inspected —

Recorder: Chart removed — Supply roll — days remaining

Weather conditions Clear Wind

Measurement: reading, cableway, boat, ice cover. Upstream, downstream side of bridge

— m, km above, below gauge

Remarks: Include condition of station equipment

Computed by KS Checked by Group

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES

Wading

Station 2½ 6m groynes

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time sec	Velocity: At point	Velocity: Mean	Area	Discharge
OPEN	.5	0							0	
1.0	1	0.17		0.6	5	46	0.080	0.080	0.17	.014
2.0	1	0.17		0.6	20	51		0.274	0.17	.047
3.0	1	0.19		0.6	15	50.5		0.207	0.19	.039
4.0	1	0.46		0.6	50	40.5		0.840	0.46	.386
5.0	1	0.38		0.6	50	46		0.740	0.38	.281
6.0	1	0.44		0.6	60	46		0.887	0.44	.390
7.0	1	0.55		0.6	50	42.5		0.800	0.55	.440
8.0	1	0.55		0.6	80	47		1.155	0.55	.635
9.0	1	0.54		0.6	80	45		1.206	.54	.651
10.0	1	0.50		0.6	80	47.5		1.143	0.50	.572
11.0	1	0.46		0.6	100	42		1.613	0.46	.742
12.0	1	0.46		0.6	80	42		1.292	0.46	.594
13.0	1	0.43		0.6	80	48		0.850	0.43	.366
14.0	1	0.40		0.6	60	45.5		0.896	0.40	.354
15.0	1	0.23		0.6	20	46		0.300	0.23	.069
16.0	1	0.21		0.6	40	41		0.665	0.21	.140
17.0	1	0.16		0.6	30	53		0.389	0.16	.062
RDLEW	.5	0							0	
									6.30	5.786
								mean vel		
								.918		

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge

HYDROMETRIC SURVEY NOTES

Station CASTLE RIVER, NEAR THE RODEO GROUNDS Sta. No. (RIGHT EMBANKMENT STRUCTURE #3 (LOOKING DOWNSTREAM))

Date APRIL 10 19 95 Party UCHIKURA, KITAGAWA, SCHELL, SKIFTON

Temp. A — °C W — °C Width 14.0 m Area 7.14 m²

Mean vel. 0.691 m/s Corr. M.G.H. — Discharge 4.93 m³/s

Measurement began at 11:45 AM ended at 12:30 PM

Levels obtained NO

Gauge Readings				
Time	Vertical	Pan	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number TT 0230

Date calibrated FEB. 18, 1986

Current meter — m

above — weight.

Method 0.2, 0.6, 0.8 Coeff. —

No. of vert. sect. 15

Angle of flow 1

Observer visited N/A

Book inspected N/A

Recorder: Chart removed. Supply roll days remaining

Weather conditions PARTLY CLOUDY Wind BRISK

Measurement: (Wading), cableway, boat, ice cover. Upstream, downstream side of bridge

m, km above, below gauge

Remarks: Include condition of station equipment

TAG LINE WAS SET UP BETWEEN SHORE AND A FISH ENHANCEMENT STRUCTURE AT LEFT BANK. WATER WAS PRESENT BETWEEN STRUCTURE AND LEFT BANK, WHICH WAS MEASURED

EQUIPMENT O.K.

Computed by CS Checked by JK

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES

Station

Distance from initial point (m)	Width (m)	Total depth: W.S. to bottom ice	Depth under ice: Of water (m)	Depth under ice: Of observation	Revolutions	Time (s)	Velocity (m/s): At point	Velocity (m/s): Mean	Area (m^2)	Discharge (m^3/s)
1.0	0.500		.09		RB	7.11.4	STOP	—	0.040	0.00
2.0	1.000		.22		10	57.6		.123	0.220	0.027
3.0	1.000		.12		40	46		.592	0.120	0.071
4.0	1.000		.66		30	65		.317	0.660	0.209
6.0	1.000		.61		80	59		1.005	0.610	0.613
6.0	1.000		.8	0.16	80	49	1.107	1.170	0.800	0.936
				0.64	80	44	1.232			
7.0	1.000		.78	0.156	80	47.5	1.275	1315	0.780	1.026
				0.624	80	40	1.355			
8.0	1.000		.65		80	48.5		1.118	0.650	0.727
9.0	1.000		.72	0.144	80	48	1.130	1.362	0.720	0.981
				0.576	100	42.6	1.593			
10.0	1.000		.69		80	47.5		1.142	0.690	0.798
11.0	1.000		.69		81	52		1.043	0.690	0720
12.0	0.875		.64		3/4	1 OF	11.0	0.782	0.560	0.438
12.75	1.000	Post Submerged Marker Installed	.48		3/4	1 OF	14.0	0.169	0.480	0.225
14.0	1.125		.88		15	46		.225	0.090	0.020
15.0	0.500		.06		LB	7.12.30 PM	—		0.030	0.000
								0.691	7.14	4.98
	14.000									6.64

Station

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge

GH + .8m

HYDROMETRIC SURVEY NOTES

Station Carbide River Stn. No. Above 11 : Weir at Bluffs.

Date April 10 1995 Party Kendall S., Brant M., Mike M., Dean B.

Temp. A 1.5 °C W — °C Width 21.5 m Area 7.38 m²

Mean vel. .664 m/s Corr. M.G.H. — Discharge 5.498 m³/s

Measurement began at 1:50 p.m. ended at 3:00 p.m.

Levels obtained

Gauge Readings				
Time	Vertical	Pan	Inside	Outside
Weighted M.G.R.	—			
Correction	—			
Correct M.G.H.	—			

Meter number NA 5137

Date calibrated Jan 30 1990

Current meter — m

above — weight.

Method 2 : 6 : 8 Coeff. .988

No. of vert. sect. 21

Angle of flow —

Observer visited —

Book inspected —

Recorder: Chart removed — Supply roll — days remaining

Weather conditions Fair Wind Slight : steady wind.

Measurement: (Wading), tagloway, boat, ice cover. Upstream, downstream side of bridge

— m, km above, below gauge —

Remarks: Include condition of station equipment

Computed by Mike M. Checked by Group

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES

Wading

Station ① above V-weir at First Riffles.

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time (sec)	Velocity At point	Velocity Mean	Area	Discharge
REW	.5	0								
1.0	1	0.04		0.6	10	43		0.164	.04	.007
2.0	1	0.06		0.6	10	42		0.167	.06	.010
3.0	1	0.07		0.6	15	58.5		0.180	.07	.013
4.0	1	0.09		0.6	10	48		0.147	.09	.013
5.0	1	0.13		0.6	20	42		0.338	.13	.043
6.0	1	0.14		0.6	20	53		0.261	.14	.037
7.0	1	0.23		0.6	30	56.5		0.365	.23	.084
8.0	1	0.29		0.6	30	41.5		0.494	.29	.143
9.0	1	0.40		0.6	40	44.5		0.613	.40	.245
10.0	1	0.50		0.6	20	40		0.344	.50	.172
11.0	1	0.63		0.6	30	46		0.447	.63	.282
12.0	1	0.62		0.6	40	43		0.634	.62	.393
13.0	1	0.66		0.6	40	47.5		0.642	.66	.424
14.0	1	0.77		0.6	50	41		0.830	.77	.639
15.0	1	0.72		0.8	40	49	0.557	0.833	.72	.600
				0.2	80	49	1.108			0.662
16.0	1	0.78		0.8	20	42	0.328	0.849	.78	.627
				0.2	100	49.5	1.370			
17.0	1	0.69		0.6	80	50.5	1.015	1.076	.69	.742
18.0	1	0.63		0.6	60	45.5		0.846	.63	.564
19.0	1	0.45		0.6	80	46.5		0.877	.45	.395
20.0	1	0.34		0.6	20	51.5		0.269	.34	.091
21.0	.75	0.15		0.6	15	40		0.091	.11	.010
REW	.25									
	21.5						Mean	.664	8.78	5.498

Station

Distance from initial point	Width	Total depth W.S. to bottom ice	Depth under ice Of water	Depth under ice Of observation	Revolutions	Time	Velocity At point	Velocity Mean	Area	Discharge

Station: Castle River at Habitat Enhancement Site

Distance from inital point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
0	0.5	(-1)	—		—	—				—
.0	1.0		0.05		0	0		0	0.05	0
.0	1.0		0.13		15	44.0		0.238	0.13	0.031
.0	1.0		0.18		20	51.5		0.272	0.14	0.049
1.0	1.0		0.25		30	43.5		0.474	0.25	0.119
.0	1.0		0.25		50	52		0.656	0.25	0.164
.0	1.0		0.35		50	47		0.725	0.35	0.254
.0	1.0		0.42		60	48.5		0.841	0.42	0.353
1.0	1.0		0.46		90	45		1.203	0.46	0.553
1.0	1.0		0.48		80	54.5		0.995	0.48	0.478
2.0	1.0		0.49		100	48.5		1.393	0.49	0.683
1.0	1.0		0.48		80	48.5		1.244	0.48	0.597
2.0	1.0		0.69		80	52		1.043	0.69	0.720
3.0	1.0		0.62		100	51.5		1.313	0.62	0.814
1.0	1.0		0.58		100	42.5		1.584	0.58	0.921
5.0	1.0		0.49		40	42		0.650	0.49	0.319
6.0	1.0		0.31		50	45.5		0.748	0.31	0.232
7.0	1.0		0.32		15	100.5		0.112	0.32	0.036
8.0	1.0		0.21		0	0		0	0.21	0
9.0	1.0		0.12		0	0		0	0.12	0
10.0	1.0		0.10		0	0		0	0.10	0
11.0	1.0		0.08		0	0		0	0.08	0
12.0	1.0		0.12		0	0		0	0.12	0
13.0	0.5		0.09		0	0		0	0.06	—
13.5	0.25	(-1)	0.04		0	0		0	0.01	0
									7.34	6.323

Station: Castle River above Weir site & below Weir

Distance from inital point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
0	0.5	(-2)			0	0		0		
1.0	1.0		0.03		0	0		0	0	0
2.0	1.0		0.04		0	0		0	0	0
3.0	1.0		0.14		10	43		0.168	0.14	0.024
4.0	1.0		0.19		20	51.5		0.272	0.18	0.049
5.0	1.0		0.28		15	47		0.226	0.28	0.063
6.0	1.0		0.28		30	47.5		0.435	0.28	0.122
7.0	1.0		0.37		30	49.5		0.414	0.37	0.155
8.0	1.0		0.46		40	43.5		0.628	0.46	0.290
9.0	1.0		0.48		30	53.5		0.348	0.48	0.166
10.0	1.0		0.54		40	46		0.594	0.54	0.309
11.0	1.0		0.63		50	47		0.725	0.63	0.457
12.0	1.0		0.76	2/10	50	44.5	0.765		0.76	0.569
	1.0			8/10	50	46.5	0.732	0.749		
13.0	1.0		0.92	2/10	50	42	0.809		0.92	0.649
				4/10	50	44	0.773	0.791		
14.0	1.0		1.12	2/10	70	47.5	0.999		1.12	0.847
				8/10	40	53.5	0.513	0.756		
15.0	1.0		1.04	2/10	60	42	0.969		1.04	0.789
				8/10	40	50	0.548	0.759		
16.2	1.0		0.69		20	52		0.398	0.69	0.275
17.0	1.0		0.48		30	47		0.439	0.48	0.211
18.0	1.0		0.43		30	53.5		0.348	0.43	0.147
19.0	1.0		0.22		15	44		0.240	0.22	0.052
20.0	0.5		0.20		0	0		0	0.10	0
									9.10	5.214

Dean Baynes + Brent Magnay debriefed with us.

HYDROMETRIC SURVEY NOTES

Station: Castle River @ Weir Sta. No.: @ Weir

Date: April 10 19 95 Party: Dave Sommer, Val Merrick, Dean Baynes, Brent Magnay, Daryll Mckee, Lee Dilbaer

Temp. A: 7 °C W: ..... °C Width: 18.56 Area: 8.42 m²

Mean vel.: 0.835 m/s Corr. M.G.H.: ..... Discharge: 7.032 m³/s

Measurement began at: 1:00 pm ended at: 2:00 pm

Levels obtained: .....

Gauge Readings				
Time	Vertical	Pen	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number: NA 7104

Date calibrated: March 19, 1990

Current meter: ..... m

above: ..... weight.

Method: 2:8:6 Coeff. .....

No. of vert. sect.: 20

Angle of flow: ⊥

Observer visited: .....

Book inspected: .....

Recorder: Chart removed: ..... Supply roll: ..... days remaining

Weather conditions: Partly Cloudy Wind: W @ 5 km

Measurement: (Wading) cableway, boat, ice cover. Upstream, downstream side of bridge

..... m, km above, below gauge

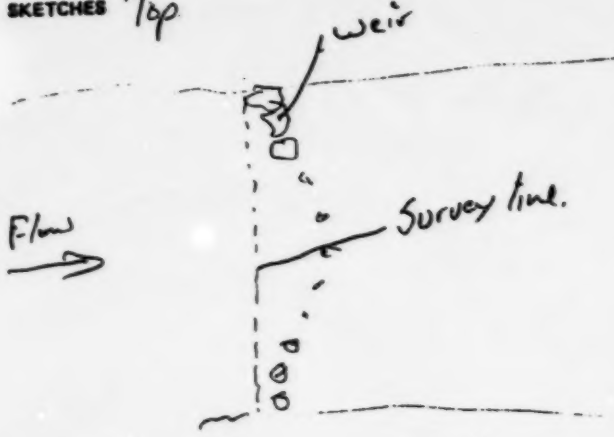
Remarks: Include condition of station equipment .....

Computed by: ..... Checked by: .....

LEVEL NOTES #: .....

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES Top



Station

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge
REW 0	0.50		-							
1	1.00		0.06						0.060	
2	1.00		0.17		10	43.0		0.158	0.170	0.027
3	1.00		0.34		20	45.0		0.302	0.340	0.103
4	1.00		0.42		15	40.0		0.255	0.420	0.107
5	1.00		0.57		30	41.0		0.497	0.570	0.293
6	1.00		0.58		50	48.0		0.443	0.580	0.257
7	1.00		0.55		60	44.5		0.918	0.550	0.505
8	1.00		0.69		80	48.5		1.120	0.690	0.773
9	1.00		0.58		80	54.0		1.006	0.580	0.583
10	1.00		0.68		80	52.5		1.035	0.680	0.704
11	1.00		0.91	0.182	100	42.5	1.598	1.284	0.910	1.168
				0.728	60	42.0	0.970			
12	1.00		0.49		100	47.5		1.430	0.490	0.701
13	1.00		0.58		80	49.0		1.294	0.580	0.751
14	1.00		0.64		60	45.5		0.896	0.640	0.573
15	1.00		0.50		40	43.0		0.647	0.500	0.324
16	1.00		0.20		20	46.0		0.285	0.200	0.057
17	1.00		0.30		20	50.0		0.272	0.300	0.082
18	0.78		0.18		15	64.0		0.159	0.140	0.022
18.56 REW	0.28								8.42	7.032
18.56	18.56									

Station

Distance from initial point	Width	Total depth: W.S. to bottom ice	Depth under ice: Of water	Depth under ice: Of observation	Revolutions	Time	Velocity: At point	Velocity: Mean	Area	Discharge

HYDROMETRIC SURVEY NOTES

Station CASTLE RIVER, BELOW V-WEIR Sta. No. –

Date APRIL 10 19 95 Party ICHIKURA, KITAGAWA, SCHELL, SKIPTON

Temp. A. – °C W – °C Width 21.74 m Area 14.68 m²

Mean vel. 0.317 m/s Corr. M.G.H. – Discharge 4.65 m³/s

Measurement began at 1:20 PM ended at 2:10 PM

Levels obtained NO

Gauge Readings				
Time	Vertical	Pan	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number TT 0230

Date calibrated FEB. 18, 1986

Current meter – m

above – weight.

Method 0.2, 0.6, 0.8 Coeff.

No. of vert. sect. 24

Angle of flow 1

Observer visited N/A

Book inspected N/A

Recorder: Chart removed. Supply roll. days remaining

Weather conditions PARTLY CLOUDY Wind CALM

Measurement: (Wading), cableway, boat, ice cover. Upstream, downstream side of bridge

m, km above, below gauge

Remarks: Include condition of station equipment

EQUIPMENT GOOD

A

Computed by CS Checked by SK

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES

Station	Distance from initial point (m)	Width (m)	Total depth: W.S. to bottom ice	Depth under ice: Of water (m)	Depth under ice: Of observation	Revolutions	Time (s)	Velocity (m/s): At point	Velocity (m/s): Mean	Area (m^2)	Discharge (m^3/s)
.0											
.10	1.0	0.500		0.08		RB	?	1:20 PM	0.000	0.040	0.00
.20	2.0	1.00		0.16		10	60.0		0.118	0.160	0.019
.30	3.0	1.00		0.17		20	52.0		0.265	0.170	0.045
.40	4.0	1.00		0.32		20	54.6		0.253	0.320	0.081
.50	5.0	1.00		0.34		15	54.0		0.193	0.340	0.066
.60	6.0	1.00		0.51		15	54.5		0.191	0.510	0.097
.70	7.0	1.00		0.70	0.14	10	43.0	0.162	0.266	0.700	0.186
.75					0.56	30	66.6	0.370			
.80	8.0	1.00		0.83	0.166	20	48.5	0.283	0.328	0.830	0.272
.85					0.664	30	55.0	0.373			
.90	9.0	1.00		1.01	0.202	10	54.0	0.130	0.261	1.010	0.264
.95					0.808	30	62.5	0.391			
1.00	10.0	1.00		1.06	0.212	30	61.0	0.337	0.391	1.060	0.414
.95					0.848	30	46.0	0.445			
.90	11.0	1.00		1.08	0.216	30	51.0	0.402	0.458	1.080	0.495
.85					0.864	40	53.0	0.514			
.80	12.0	1.00		1.04	0.208	30	63.0	0.327	0.473	1.040	0.492
.75					0.832	40	44.0	0.619			
.70	13.0	1.00		1.10	0.220	30	62.0	0.332	0.450	1.100	0.495
.65					0.88	40	48.0	0.568			
.60	14.0	1.00		1.15	0.23	30	40.5	0.506	0.574	1.150	0.660
.55					0.92	50	53.0	0.642			
.50	15.0	1.00		1.05	0.210	30	56.0	0.373	0.476	1.050	0.500
.45					0.840	40	47.0	0.579			
.40	16.0	1.00		0.96	0.192	30	41.0	0.499	0.531	0.960	0.510
.35					0.768	40	48.5	0.562			
.30	17.0	1.00			0.94	0.188	20	53.0	0.260	0.400	0.940	0.376
.25						0.752	40	50.5	0.540			
.20	18.0	1.00			0.44	0.088	30	44.0	0.465	0.402	0.440	0.177
.15						0.362	20	44.5	0.338			
.10	19.0	1.00			0.61		20	44.5		0.338	0.610	0.206
.05	20.0	1.00			0.60		20	41.5		0.330	0.600	0.198
.0	21.0	1.00			0.41		20	49.5		0.278	0.410	0.114
	22.0	1.00			0.16					0.000	0.160	0.00
	22.48	0.240	LB			?	2:10 PM					
												5.67
		21.74								0.317	14.68	4.65

Station 2 Lumbreck Cowley Rodeo grounds downstream for V-weir

Distance from initial point	Width	Total depth	Depth under ice		Revolutions	Time	Velocity		Area	Discharge
		W.S. to bottom ice	Of water	Of observation			At point	Mean		
.0	1.0	Ø							Ø	
.0	1.5	0.12			5	42		0.088	0.18	0.016
.0	1.0	0.2			10	45		0.155	0.20	0.031
.0	1.0	0.3			20	53		0.260	0.30	0.078
.0	1.0	0.3			20	42		0.326	0.30	0.098
.0	1.0	0.5			30	64		0.321	0.50	0.161
.0	1.0	0.52			30	48		0.422	0.52	0.219
.0	1.0	0.52			30	49		0.418	0.52	0.217
.0	1.0	0.56			30	49		0.418	0.56	0.234
.0	1.0	0.6			30	45.5		0.449	0.60	0.269
.0	1.0	0.64			40	44.5		0.549	0.64	0.351
.0	1.0	0.76			10	47	0.149	0.274	0.76	0.208
					30	53.5	0.398			
.0	1.0	0.74			10	46.5	0.150	0.150	0.74	0.111
					10	47	0.149			
.0	1.0	0.78			15	41	0.252	0.297	0.78	0.232
					20	40	0.342			
.0	1.0	0.86			20	44.5	0.308	0.400	0.86	0.344
					30	41.5	0.492			
.0	1.0	0.86			15	52.5	0.198	0.273	0.86	0.235
					30	59	0.348			
.0	1.0	0.86			10	46	0.152	0.250	0.86	0.215
					30	59	0.348			
.0	1.0	0.88			20	42.5	0.322	0.306	0.88	0.269
					20	47.5	0.289			

Station

Distance from initial point	Width	Total depth	Depth under ice		Revolutions	Time	Velocity		Area	Discharge
		W.S. to bottom ice	Of water	Of observation			At point	Mean		
19	1.0	0.90			10	44	0.159	0.184	0.90	0.166
					15	50	0.208			
20	1.0	0.88			15	48	0.214	0.277	0.88	0.244
					20	40.5	0.338			
21	1.0	0.88			10	45.5	0.154	0.235	0.88	0.207
					20	43	0.315			
22	1.0	0.76			10	63	0.113	0.201	0.76	0.153
					20	48	0.288			
23	1.0	0.62			30	46		0.445	0.62	0.276
24	1.0	0.48			15	46		0.225	0.48	0.108
25	0.75	0.18			5	75		0.064	0.135	0.009
25.8	0.25	Ø			—				Ø	
									4.715	4.451
25.5	25.5									
KG										

Mean velocity = .302 m³

0 .10 .20 .30 .40 .50 .60 .70 .75 .80 .85 .90 .92 .94 .96 .97 .98 .99 1.00

HYDROMETRIC SURVEY NOTES

Station Castle River @ Rocky Gorge Sta. No. LAST STATION BELOW V-WEIR

Date April 10 19 95 Party Nick Lutz, Bernie Kleinvuk, Chris Vanstaen

Temp. A 5 °C W °C Width 32 Area 13.09 m^2

Mean vel. 0.492 m/s Corr. M.G.H. Discharge 6.44 m^3/s

Measurement began at 12:45 ended at 13:45

Levels obtained

Gauge Readings				
Time	Vertical	Pan	Inside	Outside
Weighted M.G.R.				
Correction				
Correct M.G.H.				

Meter number NA 7112

Date calibrated March 9, 1990

Current meter Price 622 HA m

above weight.

Method Coeff.

No. of vert. sect.

Angle of flow

Observer visited

Book inspected

Recorder: Chart removed. Supply roll days remaining

Weather conditions Clear Wind N.W. @ 10 km

Measurement: (Wading) cableway, boat, ice cover. Upstream, downstream side of bridge

m, km above, below gauge

Remarks: Include condition of station equipment

Dwn stream of weir. Last cross section done ≈ (100 m)

Computed by Ovatie Vanstaen Checked by BCK

(IW-2078-A (1/77) R2; A(M)

LEVEL NOTES at

STATION	B.S.	HT. INST.	F.S.	ELEVATION	

SKETCHES

II NATIL.

Station

Distance from initial point	Width	Total depth	Depth under ice		Revolutions	Time	Velocity		Area	Discharge
		W.S. to bottom ice	Of water	Of observation			At point	Mean		
0	2.0		.09		10	60		.122	.180	0.0220
00	1.5		.09		5	46		.082	0.135	0.01107
20	1.0		.165		10	55.5		.131	0.165	0.0216
40	1.0		.225		20	47		.298	0.225	0.06705
60	1.0		.19		30	52		.401	0.190	0.0762
80	1.0		.23		30	55		.412	0.230	0.09476
	1.0		.27		30	60.5		.412	0.27	0.11124
	1.0		.30		30	43		.483	0.30	0.1449
	1.0		.35		30	54.5		.383	0.35	0.13405
	1.0		.43		40	52.5		.527	0.43	0.22661
	1.0		.445		30	44		.472	0.445	0.21004
	1.0		.49		40	49		.564	0.44	0.24816
	1.0		.42		50	47		.732	0.42	0.30744
	1.0		.53		50	52		.663	0.53	0.35139
	1.0		.63		50	58		.595	0.63	0.37485
	1.0		.53		20	109		0.0310	0.53	0.01643
	1.0		.43		40	54		.512	0.43	0.22016
	1.0		.47		60	58		.717	0.47	0.33664
	1.0		.47		40	43.5		.634	0.47	0.2978
	1.0		.56		30	55		.379	0.56	0.21224
	1.0		.59		40	43.5		.634	0.59	0.37406
	1.0		.60		40	50		.553	0.60	0.3318
	1.0		.72	9/10	30	44.5	.467	0.547	0.72	0.39384
	—		—	9/10	40	44	.627	—	—	
	1.0		.68		40	44.5		.620	0.68	0.4216
	1.0		.67		50	52.5		.656	0.67	0.43952

Station

Distance from initial point	Width	Total depth	Depth under ice		Revolutions	Time	Velocity		Area	Discharge
		W.S. to bottom ice	Of water	Of observation			At point	Mean		
27	1.0	.67			40	59		.478	0.67	0.32026
28	1.0	.62			40	46.5		.594	0.62	0.36828
29	1.0	.36			20	46		.304	0.36	0.10944
30	1.0	.42			30	57.5		.351	0.42	0.14742
31	1.0	.36			20	102		0.142	0.36	0.05112
32 E	.5	0						E	13.09	m
E	32 m								E	6.44 m³/s
32-0	32									